



D-31

A black silhouette of a city skyline, featuring various skyscrapers and buildings, positioned at the top of the page.

STORAGE & PRESERVATION OF MICROFILMS

C02

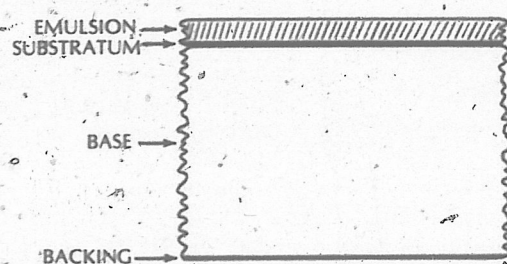
TABLE OF CONTENTS

Page		Page	
1	INTRODUCTION	6	Fungus Growth
2	DEFINITIONS	6	Microscopic Blemishes
2	Base or Support	6	Chemical Contamination
2	Emulsion	7	Theft Protection
2	Substratum	7	PROCESSING FOR PERMANENCE
2	Backing	7	Fixing Baths
2	Acetate Film	7	Time of Fixation and Replenishment
2	Nitrate Film	8	Washing
2	Polyester Film	8	Washing Aids
2	Safety Film	8	Residual Hypo Test
2	Archival-Record Film	9	Squeegee
2	RECORD CLASSIFICATION	9	Drying
3	Medium-Term Records	9	Lacquering
3	Archival Records	10	SPECIAL STORAGE AND HAZARDS
3	STORAGE HAZARDS AND PROTECTION	10	Underground Storage
3	Fire Protection	10	Effects of Nuclear Explosions
3	Storage Vaults	10	Time-Capsule Storage
3	Cabinets and Safes	11	HANDLING AND FILING FILM RECORDS
3	Effects of High Temperatures	11	INSPECTION
4	Water Protection	12	Table—Summary of Requirements for Storage and Preservation of Microfilm Records
4	Effects of High and Low Relative Humidities	IBC	REFERENCES AND BIBLIOGRAPHY
4	High Humidity		
4	Low Humidity		
5	Humidity Control		
5	Air Conditioning		
5	Moisturetight Containers		
6	Humidification		

DEFINITIONS

To help understand storage requirements, the composition and structure of microfilm are described and definitions of commonly used terms are given.

Base or Support—A flexible or rigid plastic material which is coated with a thick, light-sensitive, image-forming layer. The thickness of the base varies with different film types; it is generally 0.0025 to 0.0072 inch (2 1/2 to 7.2 mils).



Structure of a typical black-and-white negative film.

Emulsion—The image-forming layer. For unprocessed black-and-white silver films, it is composed primarily of minute silver halide crystals suspended in gelatin. Exposure to light in a camera or printer causes no visible effect, but there is an invisible change which produces a "latent image." To obtain a visible, usable image, the exposed material must be chemically processed.

Substratum—The layer which bonds the emulsion to the base. (Films for archival records have adhesion-related requirements given in ANSI PH1.28-1976¹ and ANSI PH1.41-1976².)

Backing—An optional layer intended to protect against one or more of the following: room-light loading, halation*, static, and curl. Not all Kodak silver-gelatin microfilms have a backing, but when present it is of negligible thickness, or is nearly as thick as the emulsion layer and is removable in processing (rem-jet layer).

*Halation protection is sometimes achieved in other ways, such as with base dyes or with an antihalation undercoat between the emulsion and base.

Acetate Film—A general term used to describe all films having supports made of cellulose acetate, cellulose triacetate, cellulose acetate propionate, or cellulose acetate butyrate.

Nitrate Film—A photographic film with a base consisting primarily of cellulose nitrate. Nitrate-base films decompose with age and are not suitable for permanent records. The manufacture of nitrate film by Eastman Kodak Company in the United States of America was discontinued in 1951, but older nitrate motion-picture films are often found in storage. It is not always possible to determine by visual examination if a film has a nitrate base. However, neither Kodak nor Recordak films in any width made specifically for microfilming were ever made on nitrate base.

Polyester Film—A photographic film having a polyester base. This type of base manufactured by Eastman Kodak Company is called Estar base. It is exceptionally tough and strong and has excellent dimensional stability. Microfilm emulsions on Estar base are currently supplied for many purposes.

Safety Film—Any photographic film that meets the requirements of ANSI PH1.25-1976³ or its latest revision. All safety films (both acetate and polyester) manufactured by Eastman Kodak Company meet these requirements. This means that they are difficult to ignite, are slow-burning, and are low in nitrate nitrogen content.

Archival-Record Film—Any photographic film that meets the requirements of ANSI PH1.28-1976¹ or ANSI PH1.41-1976², or their latest revisions. Such films are chemically very stable and, if properly stored, are believed to last as long as the best rag papers. Only safety film can qualify as archival-record film. To comply with ANSI specifications, archival-record films must have a gelatin-silver halide emulsion processed to a silver-gelatin black-and-white photographic image. The film must also meet certain processing requirements (see "Processing for Permanence" on page 7). Currently, all other generic types of film are excluded by implication (see ANSI specifications PH1.28 and PH1.41) from use for archival records, except for diazo films. The ANSI document⁴ on diazo films specifies that such images (formed by dyes) are not approved as archival-record films, although they may show excellent image stability for many years when stored properly.

RECORD CLASSIFICATION

On the basis of required retention, photographic records can be classified broadly into those for medium-term records and those for archival records.

Medium-Term Records—Those processed and stored to provide reasonable permanence. They include those photographic records made for general business and commercial purposes. ANSI has defined such records as covering a time span of 10 years.

Archival Records—Those processed and stored to provide maximum permanence. Any irreplaceable pictures or records that are likely to be of lasting interest should be included in this category. Historical records on microfilm are an example. All Kodak silver-halide-gelatin microfilms (except RECORDAK INSTAMATIC® Film 3453) when processed by Kodak Microfilm Processing Laboratories meet the archival standards established by the American National Standards Institute, Inc.

STORAGE HAZARDS AND PROTECTION

There are a number of hazards to the satisfactory storage of photographic film that apply to records intended for either medium-term or archival storage. In fact, it is not always possible to predict the desired life of records at the time they are made.

While films of either medium-term or archival interest are subject to the same hazards, the storage protection provided for them will differ in degree because of a number of factors. These include the cost of providing storage facilities, desired record life, frequency of record use, value of the records, etc.

Fire Protection—All Kodak microfilms are slow-burning films as defined by the American National Standards Institute, Inc.³ Even though photographic records will burn considerably slower than paper, the same precautions against damage by fire should be taken for them as for paper records of comparable value.

Depending on the importance of the records, fire protection provided can vary from the full protection described below for valuable records to that provided by ordinary office storage.

Storage Vaults—The highest degree of protection for a large number of records is afforded by a fireproof storage vault or record room. It should be located and constructed in accordance with the local building code, Fire Underwriters' Regulations, and the requirements of the National Fire Protection Association⁵ for a valuable record room, except that an approved,

controlled, air-conditioning unit should be installed. While NFPA discourages the air conditioning of such an installation, the fire hazard introduced by openings for air-conditioning ducts can be overcome by the use of Underwriters'-approved, automatic, fire-control dampers. These can be installed in the ducts in accordance with recommendations of NFPA⁶. Sufficient insulation should be provided in the vault to permit satisfactory temperature control at all seasons of the year and to prevent moisture condensation from forming on the walls.

Cabinets and Safes—For smaller quantities of records, a fire-resistant cabinet or safe of the type described by NFPA⁵ will provide considerable protection. Such a safe should protect records against a severe fire for at least four hours.

Many fire-resistant safes and cabinets use a type of insulation that, when heated, releases moisture and thus fills the interior of the safe with steam during a fire. This can cause melting or stripping of the film emulsion layer, and loss of the image. For protection, films stored in such a safe should be placed in moisture-tight cans, as described under "Humidity Control."

Fire-resistant safes are also available with an inner chamber sealed against moisture. These are classified by Underwriters' Laboratories, Inc., as Class  Record Containers.⁷ Film damage caused by steam is not a problem with these safes.

The question is sometimes raised as to whether microfilm stored in drawers or cabinets designed to resist fire for several hours might, in case of a fire, generate enough pressure to damage or explode the cabinet. There is practically no danger of an explosion from the storage of either Estar base or acetate base safety film under these conditions. There are in acetate film base small amounts of organic materials, as well as moisture, which will expand under heat and, under some conditions, might generate slight pressure. However, such intense heat would be required on the outside of the fire-resistant cabinet that the cabinet would be seriously damaged from the fire before appreciable pressure developed.

Effects of High Temperatures—In addition to complete loss by fire, damage to film records can also occur if they are exposed to very high temperatures. Excessive heat causes film to

buckle because of shrinkage at the edges. When severe, this distortion affects the ease with which the information can be taken from microfilms, either by projection (for reading) or by printing onto another film.

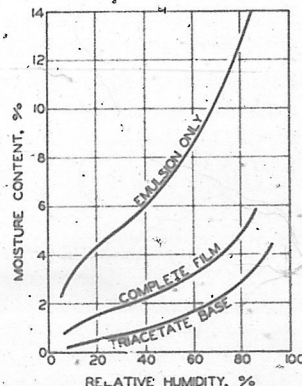
Films that have been conditioned at a relative humidity of 50 percent or lower will withstand 250°F (121°C) for 24 hours without significant loss in readability or printability. At 300°F (149°C), severe distortion may occur in a few hours.

Films that have been conditioned at a relative humidity higher than 50 percent may show objectionable distortion in somewhat shorter times or at lower temperatures. Higher humidities, however, are undesirable for other reasons, as explained in another section.

Water Protection—Film records should be protected from possible water damage, such as from leaks, fire-sprinkler discharge, and flooding. If possible, storage facilities should be located above basement levels. Storage cabinets should be raised so that the lowest shelf or drawer is at least 6 inches off the floor and should be so constructed that water cannot splash through ventilating louvers onto the records. Drains provided should have adequate capacity to keep water from a sprinkler discharge from reaching a depth of 3 inches.

If the record-storage area should become flooded, prompt steps should be taken to reclaim any records that were immersed. Allowing these records to dry even partially will cause the layers to stick together. If there are no local facilities for rewashing and drying the film immediately, the films should be placed in a water-filled container and sent to a laboratory where they can be washed and dried properly.⁸

Effects of High and Low Relative Humidities—The choice of humidity level for storage depends upon the type of photographic film and the humidity of the work area. It is preferable that the work area not be markedly different in humidity than the storage area in order to minimize subsequent moisture conditioning in storage. Very large humidity differences may lead to some physical distortion. The best relative humidity for storage is the lowest that can be achieved practically and controlled reliably, within the limits specified in ANSI PH1.43-1976.⁹

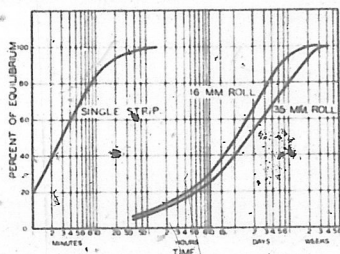


These curves show the relationship between relative humidity and the moisture content of a typical emulsion, triacetate film base, and a complete film at equilibrium at various relative humidities at 70°F (21°C).

High Humidity—Storage in moist air such as that frequently found in basement rooms, and storage humidities above 50 percent should be avoided; relative humidities of 40 percent or less are recommended for minimizing the possibility of growth of microscopic blemishes. At humidities above 60 percent, there is the additional danger of fungus growth.

Low Humidity—At low humidities, problems of brittleness or static might arise if the films are to be handled frequently. However, in the case of inactive films (regardless of their intended permanence), the increased protection that low humidity gives against microscopic blemishes might be desirable. The recommended lower humidity limit is 15 percent for acetate-base films¹ and 30 percent for polyester-base films.²

Very low humidities have, in the past, caused film to be brittle. However, film of current manufacture has not been found to exhibit brittleness or breaking tendencies under normal handling, even at relative humidities as low as 15 percent. Old film that is found to be brittle at low humidity should be reconditioned to a higher humidity before use. One day's storage is usually sufficient for conditioning a dry 16 mm roll halfway to a higher ambient relative humidity; to bring it to full equilibrium requires about a week. In each case, both sides of the roll should be exposed to the air.



Rate of conditioning a typical safety film from 20-percent to 50-percent relative humidity at 70°F (21°C).

Low humidity affects the curl of film, causing a slight contraction of the emulsion layer and resulting in a slight-curl toward that side. This is generally believed to be an advantage because the concave emulsion surface is better protected against abrasion. However, excessive curl may cause difficulty in focusing some microfilm readers. This can be avoided by conditioning the film to a relative humidity of 30 to 50 percent before use.

Film handled at very low humidities may also develop a static charge as it passes through a reader or rewinder. This static charge will attract dust particles that can damage the emulsion by chemical action or physical abrasion. Therefore, it is important that any film-handling area be kept clean. If film is kept in a dry storage area, it may be necessary to use the film in an office area of higher humidity to minimize static problems. However, as pointed out previously, large humidity differences may lead to conditioning problems.

Humidity Control

Air Conditioning—Properly controlled air conditioning of the storage area is recommended for the optimum long-time preservation of archival records. The air should be filtered to remove dust, cleansed of gaseous contaminants if necessary, and controlled to the desired relative humidity and temperature. Slightly positive air pressure should be maintained within the storage room or vault. Film should be conditioned to this environment and then placed in containers.

Where air conditioning is not practical and high humidities are likely to be present, the humidity of the storage area can be lowered by electrical refrigeration-type dehumidifiers. These are readily available and inexpensive. The

storage space should first be vapor-sealed by covering the walls with asphalt or aluminium paint or, better, paper-laminated aluminium foil or other water-vapor barriers. Painting of the storage area is suggested, but follow the painting precautions given on page 6. A humidistat set at the desired level of humidity should be used to control the dehumidifier. The humidity level should be checked frequently with a reliable hygrometer, such as a sling psychrometer. For added protection against short-term moisture effects, such as dehumidifier failure, tape the containers as described in the next section—"Moisturetight Containers".

Dehumidifiers using desiccants should only be used with caution. They create a danger of fine dust particles getting on the film and causing abrasion when the film is used. Also, when some chemical-desiccant particles are trapped in rolls of microfilm, they may form bleached spots. Therefore inert desiccants should be used and it is essential that the system be designed so that particulate material cannot enter the storage area.

Moisturetight Containers—When humidity control of the storage area is not available, storage of film in moisturetight containers is recommended to maintain humidity limits of the film. The latter must be conditioned to the required humidity before being sealed in the container. This will require the temporary use of an air-conditioned cabinet or room, or an electrical dehumidifier. Smaller quantities of film can be conditioned for 2 or 3 weeks in a desiccator containing activated silica gel, and then removed and quickly sealed.

Properly sealed metal containers do not pass moisture or gaseous impurities. They are preferred when long-term air conditioning is not practical, when gaseous impurities may regularly be present, or when low-temperature storage is used.

Although keeping experience with Kodak flip-top black polypropylene boxes has not been long term or extensive, good experience has been obtained with such containers. They are considered satisfactory where short-term protection is required against moisture or gaseous impurities, such as might occur with floods, dehumidifier failures, smoke from a fire, or moisture released by insulation (upon exposure to heat) in certain fire-resistant safes and cabinets.

With both metal and plastic containers, all materials (including any gaskets and protective paints or lacquers) must be noncorroding, and free of peroxides, reactive fumes, or exudations during storage. Closed containers with friction-type or threaded twist-on lids may require no other seal but should be tested for imperviousness. Flip-top, hinged, or telescoping lids can be used, but the joint must be sealed by several wraps of nonreactive, pressure-sensitive tape having low gas permeability. Containers should be inspected periodically for tape integrity, with tape replaced at least every 2 years, or sooner if noticeably loose.

Most Kodak microfilms no longer are supplied in metal cans; however, such cans are available from Eastman Kodak Company on special order.

Humidification—Humidification is not necessary or desirable unless the prevailing relative humidity is under 15 percent—under 30 percent for polyester-base films—for long periods of time and unless the film is used frequently and physical troubles are encountered. Neither water trays nor saturated chemical solutions should be used for humidification of storage cabinets because of the more serious danger of overhumidification. Even humidification controlled by instrumentation is risky unless "fail-safe" devices are installed.

Fungus Growth—When photographic films are stored for any length of time in an atmosphere having a relative humidity above 60 percent, there is a tendency for fungus (often called "mold" or "mildew") to grow on either the emulsion surface or the back of the film or on the film reel. The higher the relative humidity, the greater the chance of fungus attack and the more abundant its growth. (Fungus spores are found in the air everywhere, and they will germinate and grow under favorable conditions.) The only real protection against fungus growth is to make certain that the conditions are unfavorable for its growth.

If fungus growth has progressed far enough, it will cause serious and permanent damage to the film. This takes the form of distortion of the emulsion and eventually causes chemical breakdown so that the gelatin becomes sticky and readily soluble in water. Water or water solutions should not be used for the removal of fungus growth because either may lead to disintegration of the image. The film should be cleaned by wiping it with soft plush or cotton moistened

with an approved film-cleaning liquid. This procedure is described in detail in a separate pamphlet.¹⁰

Microscopic Blemishes—Some processed negative microfilms in storage for two to twenty years have developed microscopically small colored spots or blemishes. The fogged leader at the outside of the roll is most frequently affected by the blemishes, which are generally red or yellow in color and are smaller in size than the image characters (for example, a typewritten letter reduced 20X) on the microfilm. On occasion, these spots progress further into the roll and appear in image areas. A more detailed description of the blemishes and of the techniques used in inspecting microfilm is given in *National Bureau of Standards Handbook 96*.¹¹

The spots are believed to be caused by local oxidation of image silver, resulting in the formation of minute deposits of colored colloidal silver.^{12,13} Possible oxidizing agents entering from outside the roll of microfilm are aerial oxygen, whose action on the film is strongly accelerated by moisture, and atmospheric contaminants, such as peroxides, ozone, sulfur dioxide, hydrogen sulfide, and nitrogen oxides, all occurring in industrial atmospheres.

The use of low concentrations of potassium iodide in the fixing bath (0.2 gram per litre) has been recommended and has been found to provide a good degree of protection against these blemishes.¹³

The conditions under which microfilm is stored have been found to play an important role in the development of microscopic blemishes. Storage in cool, dry air that is free of oxidizing gases or vapors is an effective means for arresting their formation and growth. Storage in sealed metal cans is a sound preventive measure, if this is practical and consistent with the humidity requirements.

Chemical Contamination—Air contaminants may add an oxidizing or reducing effect to the atmosphere. This, in turn, may cause deterioration of film base and a gradual fading of the photographic image as well as the formation of the microscopic blemishes mentioned above. Typical examples of such contaminants are paint fumes, hydrogen sulfide, sulfur dioxide, and similar gases. If an area is to be painted, any films stored there should be removed beforehand

and should not be returned to the area for a two-week period. The removal of contaminating gases from the air requires special consideration.^{9,14,15,16,17}

Contaminants can come from illuminating gas, coal gas, and certain chemical plants; they are present in harmful concentration in most industrial and urban areas. Other contamination can come from ozone and ammonia, which are produced by certain photocopying devices. For this reason, an archival storage vault should be located as far as possible from such areas. When a contaminated atmosphere cannot be avoided, steps should be taken either to eliminate the fumes by airconditioning the storage area or to protect the film from contact with the atmosphere by sealing it in containers.

In addition to atmospheric contaminants, care should be taken about other materials kept or used in the storage area. It has already been mentioned that nitrate-base films should never be used for permanent-record films. Furthermore, such films should never be stored with safety-film records (either in the same room, or if the rooms are connected by ventilating ducts in the same building) because gases given off by decomposing nitrate film will damage or destroy the image on safety-film records.

Films not of silver-gelatin type (e.g., diazo or vesicular films) should not be wound on the same rolls, stored in the same containers, or be in physical contact with silver-gelatin films. In addition, some vesicular films have been known to give off acidic fumes, and require a separate storage housing with a separate circulating air system.⁹

The use of rubber bands around rolls of film is also to be avoided since any residual sulfur used in rubber vulcanization promotes the growth of microscopic blemishes. Adhesive tapes, tape splices, bleached papers, and printing inks may have the same undesirable effect.

Theft Protection—Safes provide good protection against the theft of valuable records. Where such records are large in number, it might require using vaults of burglarproof construction. Theft of important records involves a double peril—that of classified films falling into unauthorized hands and the complete loss of valuable information. Protection against the latter can, of course, be provided by storing duplicate records in another location.

PROCESSING FOR PERMANENCE

Processing is one of the most important factors affecting the potential permanence of photographic records. The removal of residual processing chemicals, the exclusion of dirt contamination, and uniform drying are factors normally controlled by proper processing.

Processed film for archival records must meet the requirements of PH1.28-1976¹ and PH1.41-1976². Ability to meet most of these requirements is controlled in film manufacture, but films must be fixed and washed adequately, whether given conventional or full-reversal processing, so as to meet residual thiosulfate requirements. Films processed without fixation, such as in halide-reversal processes and certain reversal processes with redevelopment, may give a "visible, usable image," but do not come under the scope of the archival standards.

If fixing and washing are inadequate, thiosulfates, or silver salts, or both, will be retained by the film. These can break down, especially under poor storage conditions, to produce yellow stain in clear areas and fading in areas containing image silver. The effect of these residual compounds is discussed further in Appendices A and B of PH1.28-1976¹ and PH1.41-1976². If films are properly fixed and uniformly washed so as to meet specified thiosulfate limits, residual silver salts are believed to have an acceptable level, and no separate test is specified for such silver.

Fixing Baths—In the fixing step, the undeveloped silver-halide crystals in the emulsion are converted to soluble silver compounds which can be washed away with water. The chemicals most commonly used for fixing are sodium or ammonium thiosulfate (commonly called "hypo"). The fixing bath may also contain other chemicals to maintain a desirable pH, provide hardening, stabilize the solution, protect the image from microscopic blemishes, etc.

For maximum washing efficiency, a nonhardening fixer, or a hardening fixer plus a nonoxidizing washing aid, such as KODAK Hypo Clearing Agent, should be used.

Time of Fixation and Replenishment—To make sure that there is enough time for the fixing reaction to be completed, specific recommendations for each type of film should be followed. A good rule of thumb is that the fixing time should be at least twice the time it takes to clear the milky appearance from the emulsion.

Prolonged fixing should be avoided since, in time, the hypo will start to dissolve the silver image.

Undeveloped silver halides are dissolved by the fixer as complex ions of silver and thiosulfate. As the silver content of the fixer increases with processing, the silver-thiosulfate complex becomes increasingly difficult to wash from the film. This is avoided by frequent replacement or proper replenishment of the fixing bath, or by electrolytic recovery of silver from the fixer.

To provide complete fixing, it is a good plan to use two baths, treating the film in the first bath until the emulsion has cleared and then transferring it to the second bath for an equal time. The first bath does most of the work, and the second bath maintains an acceptably low silver content so as to permit effective washing. When the first bath approaches exhaustion, it is discarded and the second bath is put in its place. A fresh fixer is then prepared and used for the second bath. In this way, the second fixer bath is kept fresh and active.

This principle can be applied to replenished processes by adding fresh replenisher to the second fixer tank and using the overflow to replenish the first fixer tank.

Recovery of silver from fixer is advisable for reasons of economics, conservation, and ecology. There are three principal methods of silver recovery¹⁸: by metallic replacement, electrolytically, or by sulfide precipitation. Of the three methods, electrolytic recovery offers additional benefits in that the fixer can continue to be used in processing, and its reduced silver level gives increased efficiency of the fixer and permits better washing.

Washing—Adequate washing is essential to the permanence of microfilm. After all of the undeveloped silver halide has been converted, the emulsion is still saturated with the chemicals of the fixing bath and some dissolved silver compounds. If these were not removed by washing, they would slowly decompose and attack the image, causing discoloration and fading. The effect is accelerated greatly by high humidity and temperature. Also, the smaller the grain size of the image, the greater is this reaction. Since most microfilms are very fine grained, they are very sensitive to this effect.

For good washing, a rapid flow of fresh water should be used. The water should be filtered to

remove dirt particles. To improve washing, countercurrent systems and spray systems are possibilities in processing-machine construction. Washing efficiency decreases rapidly with decreased temperature and is very low at temperatures below 60°F (15.5°C). High wash-water temperatures produce the most efficient washing, but emulsion reticulation can result if the wash-water temperature is too high or if it is not kept close to that of the other processing solutions. In some cases, extremely soft water can also cause reticulation.

Washing Aids—Using a washing aid, such as KODAK Hypo Clearing Agent, or its equivalent, greatly increases both the rate and thoroughness of hypo removal during the washing step. This treatment is especially recommended when an acid hardening fixer has been used.

After fixing, the film is first rinsed to remove the major portion of hypo; next the film is treated in KODAK Hypo Clearing Agent Bath; then it is given a final wash.

NOTE: The use of hypo eliminators, such as KODAK Hypo Eliminator HE-1, is not recommended for microfilm because these eliminators contain oxidizing agents that can contribute to the formation of emulsion blisters and microscopic blemishes.

Residual Hypo Test—The accepted criterion for adequate washing is the Methylene Blue Method described in ANSI PH4.8-1971¹⁹ and specified in PH1.28-1976¹ and PH1.41-1976². PH4.8 also describes the Silver Densitometric method, which has been suggested by the National Micrographics Association as a simpler and less expensive alternative.²⁰ If the silver densitometric density difference is 0.02 or less, NMA considers that the Methylene Blue requirements for archival-record films have been met. By either of these methods, a clear area of the film is tested and they allow residual hypo tests to be run up to two weeks after processing. An even simpler, but less sensitive, method is the use of the KODAK Hypo Estimator in conjunction with KODAK Hypo Test Solution HT-2. This test gives an indication of residual hypo, but it should not be used as a measurement for meeting the requirements of the ANSI specification.

NOTE: For satisfactory residual hypo levels in films, both fixing and washing must be acceptable — inadequacies in one can be compensated only partly by the other.

Squeegee—The use of an adequate squeegee as the film leaves the water wash and enters the drying section is very important. Otherwise, residual water droplets will dry to form visible surface defects and in some cases, cause physical sticking of the film laps. In wound-up rolls, these spots may provide places where microscopic blemishes can form. Inspect squeegees regularly (particularly blade and roller types) to make sure they do not cause film scratches.

Drying—Drying should be uniform. The drying air should be filtered so that airborne particles of dirt or potentially harmful chemical dusts often present in processing laboratories will not become imbedded in the emulsion while it is tacky.

Films that are to become a part of an active file system should not be over-dried. (Film that is too dry will not only tend to be brittle but will also be prone to static electricity so that it will pick up dust easily.) At the same time, it should be dry enough so that, when it is stored, there will not be an excessive amount of moisture that could promote defects. A good aim point is 35-percent relative humidity at 70°F (21°C).

Lacquering—Extensively used microfilm records are often damaged by abrasion and scratching. Thus, for some active files, lacquering with removable lacquer is economically justified. Under rough handling, of course, the lacquer coating itself may become abraded; but if so, it can be removed and a new coating applied. The film can thus be completely rejuvenated, provided that the scratches have not reached the film emulsion.

A second advantage of a lacquer coating is that it offers some protection from fungus growth if the film is stored improperly. Fungus growth will start on the lacquer surface before attacking the emulsion layer. If discovered in time, the lacquer can be removed and the film will be undamaged. A lacquer coating will also keep adjacent film layers of microfilm records from sticking together when subjected to very high humidities.

It should be recognized that while lacquers have advantages for working prints receiving hard use, they are not within the scope of the ANSI archival-film specifications^{1,2}.

SPECIAL STORAGE AND HAZARDS

Underground Storage—Most large industrial organizations and government agencies have developed methods for safeguarding vital records in the event of a war or a natural catastrophe. Many keep their vital records in underground repositories located many miles from large metropolitan areas. When microfilm is kept underground in caves, mines, tunnels, subbasements, or similar locations, special care should be taken to make certain that there is adequate control of the relative humidity.

Film should not be stored where the relative humidity exceeds the limits recommended for medium-term or archival storage. If humidity cannot be controlled satisfactorily, the film must first be dried (as described earlier in the "Air Conditioning", section on page 5) and then placed in a moistureproof container. The film must also be protected, as in other types of storage, against airborne dirt or chemical contamination.

Frequently in underground situations, proper film-storage conditions can be achieved by simply heating the cool, moist air that is present. For example, conditions in a typical mine may be 50°F (10°C) and 85-percent relative humidity; by heating the storage area to 70°F (21°C), the relative humidity is reduced to 40 percent. Where it is not practical to lower the relative humidity adequately by this means, supplementary dehumidification may be required.

Effects of Nuclear Explosions—The protection of vital microfilm records against the effects of nuclear explosions is mostly a matter of providing sufficient blast and fire protection. Processed microfilm is essentially unaffected by radiation even of the intensity encountered in the vicinity of a nuclear explosion. Best protection from blast and fire is afforded by removing security files from potential target areas. Storage in underground vaults, with duplicate copies in different locations, provides the greatest security.

Time-Capsule Storage—Microfilms to be placed in time capsules or sealed in the cornerstones of buildings require special preparation. The film should be processed according to ANSI PH1.28-1976¹ or ANSI PH1.41-1976² and then conditioned to a low relative humidity (20 to 30 percent is recommended) prior to packaging. The film can be conditioned by placing the roll in a conditioning room or chamber so that air is circulated against both roll surfaces. Conditioning times should be at least two weeks for 16 mm film and four weeks for 35 mm film.

During conditioning, the film should be in the form intended for final storage (wound on itself or a glass rod, not on a conventional core or reel) because the possibility of rapid moisture change makes it inadvisable to rewind the film after conditioning. The capsule should be loaded in the conditioning chamber, if possible; if not, the film should be transferred immediately to the capsule and sealed tightly.

The capsule should be a stainless steel cylinder which can be sealed tightly with a screw-on gasketed cover. When there is more than one roll of film, it is a good idea to separate them by a stainless steel disk of the same inside diameter as that of the capsule. Usually, cores, reels, or wrapping of any kind are not included so that only the film itself is put into the capsule.

HANDLING AND FILING FILM RECORDS

Well-planned filing systems and the proper handling of film records are important in the storage of records. The custodian should set up safeguards against loss or misplacement of valuable records and also make sure that the methods of filing and handling do not add unnecessary wear to the records. Where films are used frequently, duplicates should be made for this purpose and the originals retained in storage.

Continual handling of film, even under favorable conditions, causes some wear; but wear will be accelerated greatly by certain factors which can be controlled. Scratching can occur if the film is dirty or the equipment is poorly maintained or wrongly used; "cinching," which also causes scratches, occurs when the film is allowed to slide, layer on layer (for example, when the end of a loose roll of film is pulled); tearing and fingerprinting occur if the equipment and handling methods are not suitably chosen for the work.

Dirt can be removed from film by wiping it with a lintless fabric pad moistened with KODAK Film Cleaner or its equivalent. The cleaning operations should be carried out in an atmosphere of about 50-percent relative humidity to minimize the possibility that the film will become electrostatically charged and attract dust particles.

Cleanliness of the work space is essential to success in these operations. Static discharge devices are available for use when handling film which has been in dry storage. Alternatively, the film can be conditioned to a higher relative humidity before cleaning and then reconditioned to the original low relative humidity. Other suggestions for improving handling operations can be found in *Selection and Use of KODAK and EASTMAN Motion Picture Films*.²¹

INSPECTION

The potential life of photographic records depends largely on atmospheric conditions — temperature, humidity, cleanliness — and the manner in which the film is used. If storage conditions are kept within the limits suggested in the table on page 12, inspection of an adequate number of properly selected lot samples should be made at two-year intervals.⁹

While archival records should definitely be kept under the recommended storage conditions, film records of medium-term value may have more leeway in terms of storage humidity and temperature. Where humidity is not controlled closely, film should be inspected more frequently than at two-year intervals. Depending on the extent and duration by which temperature and humidity exceed the recommended ranges, the intervals between inspection should not initially exceed six months and then, if no deterioration is noted, can be extended but not to exceed one year.

Sometimes film inspection is considered to be too laborious and costly and is neglected for many years, occasionally with unfortunate results. Perhaps it is not always possible to open every film can or to rewind every roll at the recommended frequency. Rather than omit inspection entirely, a few rolls should be selected at random from the film collection each month for examination. This will provide some protection at a relatively small cost. If there is indication that film records are not keeping properly, storage conditions should be improved and other protective treatments given the film. Also, copies should be made of films that show signs of deterioration.

SUMMARY OF REQUIREMENTS FOR STORAGE AND PRESERVATION OF MICROFILM RECORDS

Storage Facilities—The selection of type of storage vault, safe, cabinet, or area must be based on the value of the film records and their intended storage life. In general, separate metal cans for individual rolls are recommended although Kodak flip-top black polypropylene boxes have been acceptable in limited experiences under good storage conditions. Either type of container should be stored in metal cabinets which have adjustable shelves or drawers and louvers or openings in the walls to allow free circulation of conditioned air through the cabinet. Cabinets should be spaced in the room so as to eliminate any stagnant air pockets or localized areas where temperature and humidity may reach higher levels than the general condition.

Although the same storage principles apply to medium-term as well as archival records, much greater care must be taken to obtain maximum protection for archival records; makeshift or temporary arrangements should not be considered.

In summary, the following conditions are considered suitable for Kodak black-and-white, silver gelatin microfilms:

Film	Medium-Term Records Safety film that meets all requirements of ANSI PH1.25-1976	Archival Records Safety film that meets all requirements of ANSI PH1.25-1976 plus either ANSI PH1.28-1976 or ANSI PH1.41-1976
Residual Hypo (1)*	Not above 2 micrograms per square centimetre (2)*	Not above 0.7 microgram per square centimetre (2,3)*
Residual Silver Salts	—	(4)*
Storage Atmosphere Temperature (5)*	Preferably below 70°F (21°C); maximum of 75°F (24°C)	Maximum of 70°F (21°C)
Relative Humidity	Preferably 20 to 40%; maximum of 60%	20 to 40%
Air Conditioning	Not necessary unless film records are subjected to frequent or sustained high humidity (6)*	Essential, including slightly positive air pressure
Air Purification	Normal cleanliness	Cleanse of airborne gases, dirt particles, and other contaminants

*NOTES

- (1) Expressed as thiosulfate ion.
- (2) For films containing a gelatin backing about as thick as the emulsion layer and not removed in processing, this level is permitted in each layer (emulsion and backing).
- (3) This level is low enough to cause no visible impairment of the image after moist incubation as specified in ANSI PH1.28-1976 and PH1.41-1976. It is also safe for those records where even slight staining is unacceptable, and has a considerable safety factor where legibility is the prime consideration.
- (4) The safe maximum for residual silver salts is unknown, but it is believed the quantity of residual silver compounds will be satisfactorily low when the film meets the limits for residual thiosulfate specified in ANSI PH1.28-1976 and PH1.41-1976.
- (5) If the storage temperature is sufficiently low, or if the air where the film is to be handled is quite moist, the film must be left in its closed container until it warms up to approximate room temperature. Otherwise, condensation of moisture will occur on the cold film surfaces.
- (6) Dehumidification may be necessary even though automatic air conditioning is not practical.



Storage and Care of KODAK Color Films

Photographic films are perishable products subject to damage by high temperatures, high relative humidities, and harmful gases. Unprocessed color films are more seriously affected than black-and-white films, since adverse storage conditions usually affect the three emulsion layers to different degrees, causing changes in speed, color balance, and contrast. *Adverse storage conditions usually cause much larger changes in the color quality and speed of the film than does any permissible variation in manufacturing.* Moisture at any temperature may also cause various physical defects such as mottle and abrasions.

To prevent detrimental effects on unprocessed film, proper storage is necessary both before and after exposure. When climatic conditions are moderate, the precautions are few and simple. Greater care is necessary under hot and humid conditions.

Processed films also require proper storage and care to increase their longevity. It must be emphasized, however, that the quality of film processing plays an important part in the longevity of a transparency or negative. *Film processing recommendations should be followed very closely.*

This publication is confined primarily to still camera films. For movie films, see Kodak publication No. D-23, *Handling and Storage of KODAK and EASTMAN Motion Picture Films*.

Storage of Unprocessed Films in Original Package

Follow the film storage recommendations printed on the package. "Protect from heat" is the recommendation for Kodak color films intended for general-purpose consumer use. Kodak consumer films are manufactured to specifications which allow the films to mature into customer aims for color and contrast when the films are stored at normal room temperature. Most of the keeping changes take place shortly after the film is manufactured and before it is released to dealers. Thereafter, the film becomes more stable and further room temperature keeping changes are small. If, after testing some rolls, a photographer wishes to maintain the film at that specific color balance for an extended period, he can store other rolls of the same emulsion in a refrigerator or freezer.

Kodak professional color films should always be stored under refrigeration at 13°C (55°F) or lower.

These films are designed to give optimum quality results close to the time of film manufacture. To maintain that quality level and minimal emulsion-to-emulsion variability, refrigerated storage is necessary. Some special-purpose color films, such as KODAK EKTACHROME Infrared Film and KODAK EKTACOLOR Internegative Films 6008 and 6110, should be stored at -18 to -23°C (0 to -10°F).

Since high relative humidities are usually more harmful than high temperatures, protection from moisture is essential. To provide this protection, Kodak color films are sold in heat-sealed foil pouches, snap-cover plastic cans, and taped metal or plastic cans. Original packages, therefore, should not be opened until the film is to be used. The foil pouches containing sheet film are vapor-tight but not necessarily 100 percent lighttight and, therefore, should not be subjected to normal room light.

Continue to protect all color films from excessive heat after they have been removed from the recommended storage condition. When traveling in an automobile, put color films in an insulated picnic bag or chest. Avoid placing the container in the direct sun or on hot spots on the floor. If the car is to be parked in the sun for several hours, the temperature inside can reach 71°C (160°F), and it may be best to put the container in the trunk, avoiding hot spots on the floor. Dry ice or other cold packs can be used to keep Kodak professional color films cool.

CAUTION: Moisture may condense on film surfaces if boxes of refrigerated film are opened too soon. To avoid possible damage to the film, packages removed from cold storage should be allowed to reach approximate room temperature before they are opened. The times suggested in the table below are for single packages, standing on end or on edge. Cold packages stacked flat on top of each other require much longer times to warm up.

Type of Kodak Color Film Package	Warm-Up Times (Hours)	
	For 11°C (20°F) Rise	For 42°C (75°F) Rise
Roll film, including 828	1/2	1
135 magazines; 110 and 126 cartridges	1	1 1/2
10-sheet box	1	1 1/2
50-sheet box	2	3
35 mm, any length	3	5

After the film is removed from refrigeration, continue to protect it from adverse temperature and humidity conditions before exposure and processing; such adverse conditions may cause unsatisfactory results in spite of the previous low-temperature storage.

Use Prior to "Process Before" Date. Storage of color films at -18 to -23°C in a freezer will retard changes in film characteristics for long periods of time. For best results, however, the film should be exposed and processed prior to the date stamped on the film package. Films kept past this date may be unsatisfactory, possibly showing undesirable changes in speed, contrast, stain, and color reproduction. The magnitude of changes in the film is largely dependent on the conditions of storage. Proper storage conditions decrease the rate of the inherent changes in sensitized products, but they do not eliminate them.

Protection from X-rays. In hospitals, industrial plants, and laboratories, all films, regardless of the type of packaging, must be protected from x-rays, radium, and other radioactive materials. For example, films stored 25 feet away from 100 milligrams of radium require the protection of $3\frac{1}{2}$ inches of lead around the radium. Airline passenger carry-on luggage, in the U.S.A., is subject to inspection by low-dosage x-ray devices. Two or three of these low-dosage inspections should not cause visible effects when the film is processed. If you anticipate multiple inspections or if you do not wish to have your films subjected to x-ray inspections, you can request a hand-inspection by security officials. It is also advisable to label packages of unprocessed films to be mailed across international borders "Contents: Unprocessed Photographic Film. Please Do Not X-ray." Commercial film processing mailers are generally recognized by inspectors and are not x-rayed.

Protecting Unprocessed Films After Opening Package

When a film package is opened, the film is no longer protected from high humidity and harmful gases. High relative humidity and high temperature also can cause undesirable changes in the latent image. *Therefore, it is particularly important that a professional film be exposed and processed as soon as possible after the package is opened.*

Under adverse heat and humidity conditions, film should not remain in the camera or holders longer

than necessary. A carrying case containing film should be protected from direct sunlight, because the temperature inside the case may rise extremely high, even in a temperate region. If unprocessed film is to be kept in a closed automobile on a warm, sunny day, it should be placed in an insulated picnic bag (described previously). A few hours under such conditions without protection, either before or after exposure, is likely to have serious effects on color quality.

Film must be kept away from industrial gases, motor exhausts, paints, solvents, and cleaners. Since the vapors from mothballs and mildew or fungus preventives can have deleterious effects on film, keep all films and cameras away from clothes closets and drawers containing these preparations.

Moisture may condense on lenses or films taken from air-conditioned buildings or automobiles into much warmer and more humid outside air. Condensation may also occur on lenses or films brought inside from cold outdoor conditions. Under cold picture-taking conditions, film may snap or perforations may be ripped if the film-winding mechanism is operated too rapidly. To protect the film as much as possible, carry the camera inside your coat when it is not in use.

Professional color films that are to be processed by a commercial processing laboratory should be shipped to the laboratory immediately after exposure. In hot and humid weather, send the film by airmail or air express.

Special provision must be made for keeping exposed films cool and dry if adverse climatic conditions (temperature above 24°C or relative humidity above 60 percent) are to be expected before processing. If the weather is warm as well as humid, the desiccating chamber (described in the next section) should be kept cool during the drying period. In warm weather, exposed films, whether dried or not, should be stored in a refrigerator (if available) until they can be processed or shipped to a processing laboratory. For a day or so, the films need not be sealed, but unsealed films should be placed as far as possible from the cooling coils.

Static. Rapidly pulling sheet film from a box, pulling out film-holder slides quickly, advancing and rewinding roll film too rapidly, and removing backing paper too swiftly can produce static electricity discharges which show up as marks on the processed film. Static discharges most commonly occur when the relative humidity is low, as it is indoors during

winter months. Marks produced by static can appear as lightning streaks, small dots, or localized fogging. Faster films are more susceptible to effects of static than are slower-speed films. During dry weather, careful handling of the film and equipment, especially in advancing or rewinding film in the camera, will minimize static discharges.

Desiccating Films

In temperate climates, the desiccation of films is seldom necessary. The following instructions apply primarily in exceptionally humid regions.

The most desirable method of storing unprocessed or processed film under humid conditions involves mechanical air-conditioning with fully automatic relative humidity control. An alternative is an electrically operated refrigerating dehumidifier controlled by a humidistat. This type of installation provides less accurate control of humidity, but is adequate for dehumidifying a single room.

Use of Silica Gel. When no automatic method of humidity control can be adopted, an inexpensive expedient is the use of silica gel. It is supplied in bulk by a number of chemical supply houses. Prepared drying units, such as Davison Silica Gel Air Dryers, are available. (Write to Davison Chemical Division of W. R. Grace & Co., 10 East Baltimore Street, Baltimore, Maryland 21203, for the name of a local distributor.) These are perforated metal containers holding about 1½ ounces of silica gel, with a color indicator that turns from blue to pink when the desiccant needs reactivation.

Silica gel lasts indefinitely and can be reactivated by heating to a temperature between 149 and 204°C (300 and 400°F) in a vented oven or over a fire. In this temperature range, ½ hour is sufficient to reactivate small quantities; large quantities require 2 or 3 hours. To prevent reabsorption of moisture, allow the hot silica gel to cool in a closed metal container. Then, if the desiccant is not to be used immediately, seal the container.

For drying from equilibrium at 80 percent to equilibrium at 40 percent relative humidity, Kodak color films require approximately the amounts of freshly activated silica gel given in the following table. Larger sizes or quantities of film, or more humid conditions, require proportionately greater amounts.

Calcium chloride is not recommended as a desic-

Quantity of KODAK Color Film	Quantity of Silica Gel	Approximate Drying Time
10 sheets 5 x 7 inches (plus interleaving paper and cardboard stiffeners)	1 oz	1 week
20 rolls 620 or 120	5 oz	2 weeks
20 magazines 135, rolls 828, or cartridges 110 or 126	1 oz	2 weeks

cant because it dusts when dry, liquefies when moist, and is corrosive.

Desiccating Procedure. Drying is best carried out by placing the film and desiccant in a lighttight metal container that can be hermetically sealed by a friction lid, rubber gasket, or adhesive tape. If the desiccant is in bulk form, use a porous separator such as thin paper or fine muslin to prevent dust from reaching the film. An alternative is to solder the bottoms of two cans together all the way around. Punch holes through the two bottoms; place the film in one section and the desiccant in the other; and seal both compartments.

The cardboard stiffeners in the film package should also be dried if they are to be repacked with the film. Magazines of 135 film and spools of 828 film should be removed from their individual cans before they are placed in the desiccating chamber. Space should be left between the film units to permit air circulation.

After drying, the films can be resealed in the original container or some other moisture-tight can having a secure closure. In the case of sheet film, use KODAK Storage Envelopes for Processed Film, or equivalent. Aluminum foil wrap can be used if the ends are folded double and all joints are sealed with waterproof adhesive tape.

Films to be shipped to a processing laboratory should not be delayed unnecessarily for drying, but should be shipped, together with drying units, inside a sealed can. Desiccants in bulk form should not be used because of the danger of dust.

Care of Processed Films

It is well established that over a period of time all dyes undergo hue and saturation changes to some extent. The dyes used in Kodak color films are as stable as is consistent with the optical and chemical requirements of color processes. The primary factors affecting the permanency of the dyes in a color image are light, moisture, and heat. It should be noted also that faulty processing (such as deviations

from recommended procedures, including improper processing times, temperature, agitation, washing, and replenishment) can hasten deterioration of dye images. To delay dye image changes in properly processed films, store films in a dark, dry, and cool place. For long-term keeping, see the subsequent section.

Protection from Light. The projection life of a color slide depends upon the amount of light and heat from the projection lamp falling on the slide and upon the total projection time. Prolonged projection with high-wattage lamps or arc lamps will shorten the life of, and may even distort, the transparencies. Avoid projection times longer than 1 minute. If long projection times are unavoidable, make duplicate slides of the original and use them for projection purposes. Never remove the heat-absorbing glass or use a lamp of higher wattage than that recommended for the projector. Do not obstruct the air intake for cooling the projector. When glass-bound slides are used in high-wattage projectors, moisture may condense on the inside of the glass. This difficulty can usually be eliminated by storing slides with activated silica gel.

Original and duplicate slides made on Kodak color films can be projected many times before changes in the dye are noticeable. The dye images most stable to light are those in slides made on KODAK EKTACOLOR Slide Film 5028, KODAK EKTACHROME Slide Duplicating Film 5071 (Process E-6), and KODAK EKTACHROME Films. Slides made on KODACHROME Films are somewhat less stable, but may be expected to withstand 250 to 500 15-second projections (one projection per minute) in non-arc projectors before significant dye fading results.

Color negatives should not be subjected to light other than the normal exposure received during printing and enlarging operations. Do not allow negatives to remain on lighted illuminators for long periods of time.

Protection from Heat and Humidity. Processed films should be stored on the main floors of buildings, never in basements, which may be damp, or in attics, which may be hot. A relative humidity (RH) between 15 and 40 percent and a temperature of 21°C (70°F) or less are recommended.

It must be emphasized that *high relative humidities are dangerous* because of the possibility of fungus growth. In localities where inside relative humidities of 60 percent or higher prevail, it may be advisable to build a moistureproof box in which to

store a film collection with silica gel. Remember that silica gel needs to be replaced or rejuvenated occasionally to maintain its effectiveness. Make the box of metal or of wood lined with metal, sealing all joints with solder or another moistureproof and durable sealant. Provide a rubber gasket to make a tight-closing lid, and arrange the films to permit adequate circulation of air within the box.

A relative humidity under 15 percent should be avoided because excessive brittleness may result. Color films should never be humidified purposely, except under carefully controlled conditions.

Protection from Physical Damage. Color transparencies and negatives should be kept as clean and dust-free as possible. They should never be touched with the fingers except at the edges. Sheet- and roll-film originals should be kept in transparent KODAK Sleeves, or equivalent, which are sold by photo dealers, for protection against dirt and finger marks. At relative humidities above 60 percent (not a recommended condition), shiny spots may occur on the emulsion surface of an original stored in contact with a sleeve or, in fact, any smooth surface. These spots, as well as dirt and fingerprints, can be reduced by washing and drying the original. Use water between 18 and 24°C (65 and 75°F) and limit the washing time to a few minutes. Bathe the film for about 30 seconds in KODAK PHOTO-FLO Solution (diluted as directed on the bottle) and hang it up to dry.

If KODAK Sleeves are not used, roll-film originals are best stored in envelopes with side seams. The paper and adhesive should meet the requirements of American National Standard PH4.20-1958. A variety of containers for 2 x 2-inch slides is offered by photo dealers.

Carpet beetles and other insects which frequently inhabit old carpets, books, and stuffed furniture will damage film if it is stored near them. Such insects feast on the emulsion, and if hungry enough, will eat the base also! If you suspect that your slides have been damaged in this way, you can prevent further damage by removing and discarding the slide mounts. Clean the slides with KODAK Film Cleaner, or equivalent. Remount the slides in new mounts and place them in an uncontaminated slide box. Do not store film in the presence of moth-preventive chemicals such as paradichlorobenzene crystals. Such chemicals tend to crystallize on the film and damage adhesives used in mounts. Gases such as nitrous oxide, hydrogen sulfide, and sulfur dioxide may cause slow dye fading.

Keep films away from chemical dusts; alkaline dust particles and hypo particles on the emulsion may cause spots of dye fading after a prolonged storage period. Slide mounting glass should be cleaned to remove possible contaminants before the slides are mounted.

Most original color slides made on Kodak camera films should retain satisfactory image quality for many years, provided they have received high-quality processing; have been treated with care in respect to heat, light, humidity, and the other hazards discussed in this section; and have been stored in the dark at a temperature of 21°C (70°F) or less and a relative humidity between 15 and 40 percent. Under these conditions, original and duplicate color slides made on KODACHROME Film have the best dark storage dye stability characteristics of any current Kodak color film. No significant dye fading is normally to be anticipated on Kodachrome slides for 50 years or longer. Perceptible dye fading may be noticed on original Ektachrome slides or on duplicate slides made on EKTACHROME Slide Duplicating Film 5071 after a period of 10 to 20 years. Color negatives processed and kept under similar circumstances are capable of making satisfactory prints for a period of at least 2 to 5 years.* Much longer periods are possible for both slides (transparencies) and negatives if processed films are stored at refrigerated temperatures. Long-term keeping is discussed in the following section.

Long-Term Keeping. Any color transparency or color negative image that is intended for posterity should be separated into its three color-component parts. Three color-separation negatives (or positives) should be made on black-and-white film. The silver density images in properly processed black-and-white negatives have an estimated stable life of hundreds of years when stored under optimum conditions. Thus, these silver images can be used to produce good color images at any future time.

The best method for delaying changes in color images of transparencies or negatives is storage at refrigerated temperatures. Kodak color negatives that are stored in a refrigerator at 1.5°C (35°F) can be expected to retain satisfactory reprinting characteristics at least ten times longer (20 to 50 years) than those stored at room temperature. Storage of negatives in a freezer at -18 to -23°C should provide maximum stability of the dye images, enabling prop-

erly processed negatives to print satisfactorily after very long, indefinite periods of time. When stored at these low temperatures, the negatives must be protected to maintain the proper moisture content.

Suitable moistureproof packaging material consists of aluminum foil (such as three wraps of household heavy-duty aluminum foil) with folds and seams sealed with moistureproof tape (such as plastic electrical tape). KODAK Storage Envelopes for Processed Film, 4 x 5 and 8 x 10, made of polycoated aluminum paper material, and heat-sealable, can be purchased for storing processed films at refrigerated temperatures. These envelopes are similar to those used to package several types of unexposed Kodak film. Each envelope will accommodate about 50 sheets of noninterleaved films or a lesser number if the films are placed in sleeves or other inert enclosures. The films and enclosures in one storage envelope should be limited to a total thickness of 1/2 inch or less. Use enclosures that meet the specifications of American National Standards PH4.20-1958 and PH1.43-1971. KODAK Sleeves, or equivalent sleeves made of cellulose acetate, virgin polyethylene, or uncoated polyester (polyethylene terephthalate), are recommended to protect negatives from scratches and finger marks.

Separated films, enclosures, and storage envelopes should be preconditioned for at least an hour in a small, air-conditioned room at a temperature of 21°C (70°F) or lower, and a relative humidity between 25 and 30 percent. (One or more refrigeration-type dehumidifiers controlled by a humidistat may be necessary to achieve the desired humidity. Use a hygrometer or psychrometer to measure the relative humidity.) Insert films in individual enclosures or groups of films into a common enclosure. Carry out the film insertion and heat-sealing of the storage envelopes in the same air-conditioned room.

After inserting the films, smooth out, with light pressure, as much air as possible. Seal the opening with either a commercial heat-sealing unit or an electric (dry) flatiron at a temperature between 120 and 150°C (about 250 and 300°F). The cotton setting on most modern irons will approximate the required temperature. When making the seal, be careful that the hot iron does not get close to the films. For maximum protection from moisture, seal one sealed storage envelope within another. The sealed envelope can now be stored at refrigerator or freezer temperatures. Avoid excessive pressure on the sealed films during storage periods.

*These time periods are estimates based on accelerated testing procedures.

The preconditioning and sealing of films to be stored under refrigeration can be done periodically; every three months is a good interval.

Warm-Up Time. To prevent moisture condensation on material taken from a freezer, the package must be allowed to reach equilibrium with the room temperature before being opened. The warm-up time required depends on the temperature differential between the film and the ambient air, the dew point of the air, the quantity of film, and the size and insulation of the packaging.

Since warm-up time recommendations cannot be given for all the different conditions that might be encountered, a practical test should be made for the particular conditions. Moisture condensation is not only harmful in itself but also might lead to subsequent return of the film to storage in a high-moisture condition. Bear in mind that film should be resealed in equilibrium with low RH before it is returned to cold storage.

Cleaning Transparencies and Negatives. Light dust can be removed from color films with a clean, dry, camel's-hair brush. Light fingerprints or oily smudges can be removed by applying KODAK Film Cleaner sparingly on a plush pad or wad of cotton.

Kodak processing laboratories stopped lacquering Kodachrome transparencies and Kodacolor negatives in 1970. If you feel that your color films need protection from fingerprints, light scratches, and fungus growth, apply KODAK Film Lacquer, or equivalent, as directed on the label. A lacquered surface is more readily cleaned, and in cases of minor damage it is possible to restore the surface by removing the old lacquer and applying new. Most lacquers can be removed by either of the following methods. (If there is fungus growth on the film, use ammonia-alcohol solution method.)

Removing Lacquer with Sodium Bicarbonate. Dissolve a level tablespoon of sodium bicarbonate (baking soda) in 240 ml (about 8 fluidounces) of room-temperature water. (If used for Kodachrome transparencies, add 15 ml [$\frac{1}{2}$ fluidounce] of formaldehyde, 37 percent solution.) Agitate a transparency for 1 minute, or a color negative for 4 minutes. Rinse for 1 minute in room-temperature water. Bathe the film for about 30 seconds in KODAK PHOTO-FLO Solution (diluted as stated on the bottle), or equivalent, and hang it up to dry in a dust-free place. When

the film is completely dry it can be relacquered. Apply KODAK Film Lacquer as directed on the label.

Removing Lacquer with Ammonia-Alcohol. Add 15 ml (about a tablespoon) of nondetergent household ammonia to 240 ml (about 8 fluidounces) of denatured alcohol. Use shellac-thinning alcohol. Agitate the film in the solution for no longer than 2 minutes at room temperature. Longer times may change the color in areas of minimum density. Hang the film up to dry.

How to Treat Water-Soaked Films

Water from floods, fire-fighting, burst pipes, leaky roofs, etc. can inflict serious damage on stored negatives and transparencies. You can keep the damage to a minimum if you act quickly to salvage the films.

The first thing to remember is to keep the water-soaked films and their enclosures (mounts, envelopes, sleeves, etc) wet. Do not allow them to dry. Immerse them completely in plastic containers of cold water, below 18°C (65°F), containing about 15 ml of formaldehyde solution per liter of water. The cold water and the formaldehyde will help prevent the swelling and softening of the gelatin emulsion which are the major causes of damage and the growth of bacteria.

As soon as possible, carefully separate the films from their enclosures and wash the films for 10 to 15 minutes in water at 18°C (65°F) or lower. If necessary, the films can be swabbed, but extreme care should be taken because the wet emulsion is very susceptible to physical damage. Avoid any sudden temperature changes in the wash waters. Rinse negatives and transparencies for 1 minute in diluted KODAK PHOTO-FLO Solution.

Exposed water-soaked film should be kept wet and processed as soon as possible.

Film Notice

Kodak color films will be replaced if defective in manufacture, labeling, or packaging, or if damaged or lost by us or any subsidiary company. Except for such replacement, the sale, processing, or other handling of these films is without warranty or liability, even though defect, damage, or loss is caused by negligence or other fault.

Since color dyes may in time change, these films will not be replaced for, or otherwise warranted against, any change in color.

Professional and Finishing Markets Division
EASTMAN KODAK COMPANY, ROCHESTER, N.Y. 14650



Storage and Care of Kodak Color Films
Kodak Pamphlet No. E-30

D06

4-77-DX Minor Revision
Printed in the United States of America

KODAK, EASTMAN, EKTACHROME, EKTACOLOR, PHOTO-FLO, KODACHROME, and KODACOLOR are trademarks.

ALSO OF INTEREST

Microform Review features reviews of all micropublications. Also, articles dealing with the use of microforms in the library appear in each issue. Allen B. Veaner, editor-in-chief. Quarterly. ISSN 0002-6530. \$35.00.

Micrographics Equipment Review provides comprehensive reviews of micrographics equipment designed for library applications. Emphasis is placed on readers, reader printers, duplicators, and COM equipment. Twice yearly. ISSN 0362-1006. (Price according to book and periodical budget.)

The Micropublishers' Trade List Annual offers on microfiche the catalogs of micropublishers worldwide. Includes 143 microfiche, protective panels, binder, subject index, and contents index. Annually in June. ISSN 0361-2635. \$89.50.

Guide to Microforms in Print (Incorporating International Microforms in Print) now under the editorial supervision of *Microform Review*. A revised and increased data base of available micropublications from publishers worldwide. Entries conform to Library of Congress and Anglo-American cataloging rules. Annually in March. Cloth. ISSN 0017-5923. \$42.50 (\$38.50 for standing orders).

Supplement to Microforms in Print is a listing by author-title and subject of micropublications that have been published between annual issues of MICROFORMS IN PRINT. Annually in September. Paper. ISSN 0362-1014. \$25.00.

Subject Guide to Microforms in Print (Incorporating International Microforms in Print) provides the means to survey the extent of the micropublications available in a given subject area. Combines with the *Guide* to place extensive reference and research information at your fingertips. Annually in March. Cloth. ISSN 0090-290X. \$42.50 (\$38.50 for standing orders).



MICROFORM REVIEW INC.

520 Riverside Ave.,
P.O. Box 405 Saugatuck Station
Westport, CT 06880

BULK RATE
New Haven, CT
Permit No. 64

Library Routing

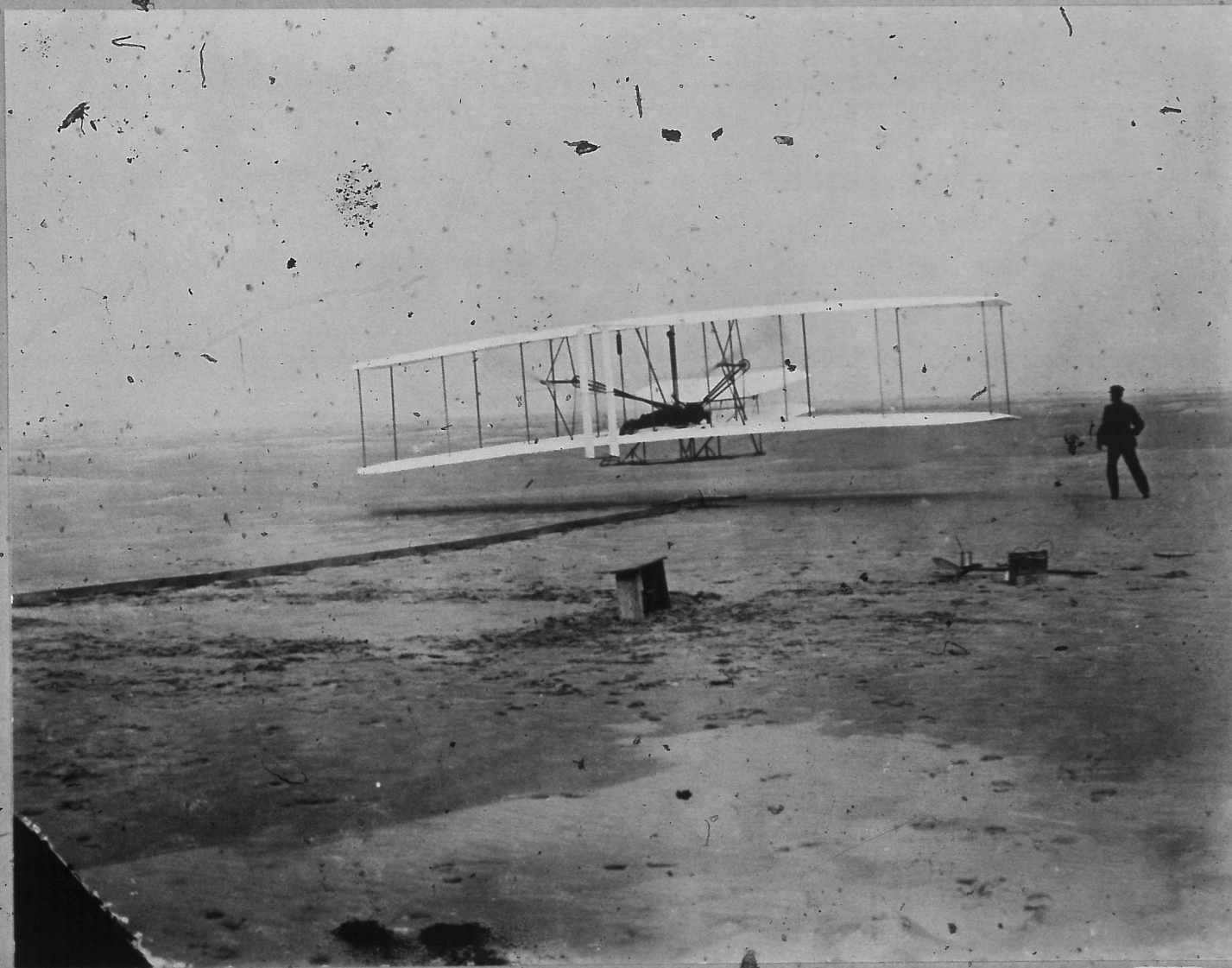
- ☐ Acquisitions
- ☐ Cataloging
- ☐ Chief Librarian
- ☐ Circulation
- ☐ General Reference
- ☐ Microforms
- ☐ Serials
- ☐ Other
- ☐ Return to

First flight, Dec. 17, 1903

Soft print from Wright Brothers Collection negative: LC-W86-35

copy negative: LC-USZ62-6166-A

LC-USZ62-6166-A



A13